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VARIATION OF BLAST PRESSURES AT FIXED DISTANCES WITH SMALL ALTITUDES

J. M. Harding, Division 5111

April 3, 1952

SANDIA CORPORATION
ALBUQUERQUE, NEW MEXICO

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LIST OF ILLUSTRATIONS

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VARIATION OF BLAST PRESSURES AT FIXED DISTANCES WITH SMALL ALTITUDES

Summary. -- The possibility of variation of peak pressures and time rate of rise to peak pressure at a fixed distance from ground zero led to the experiment described here. Measurements on each of two fifty-foot towers for Buster Shot Easy revealed no definite pattern of variation.

* * * * * * *

That blast pressures and shock arrival times appear to vary as a function of distance of the gauge above ground surface was first observed from records of the Greenhouse trials. On some structures[1] gauges were installed both near the ground and at a vertical distance of about 25 feet. The data generally indicated that the initial pressure responses of those gauges 25 feet above the earth occurred at a time somewhat later than the responses of the ground level gauges. It also appeared that the time rate of rise to maximum pressure was smaller for surface gauges than for those above the surface.

These correlations resulted from an experiment that was not planned to explore such phenomena in more than the most cursory manner. During Operation Greenhouse a series of experiments[2] was designed to explore the possible variation of peak pressure and rise time as a function of height of the gauge above ground.

For Shot Easy, on Engebi Island, a number of gauges were mounted in 'streamlined' edge-on baffles called pylons. These pylons were 15 feet high, 15 feet long, and 6.5 inches thick; the gauges were mounted at centerline in the broadside face at heights of 3.5, 7, 10, and 14 feet.

Essentially the preliminary findings from these experiments are:

Data from pylons indicated no consistent variation of peak pressure and rise time with height.

At stations less than 1000 yards from the ground zero ground station peak pressures appear to be consistently lower than average pylon pressures. At stations approximately 1,430 yards from ground zero ground station pressures appear to be very nearly equal to average pylon pressures. It is to be noted that the highest pylon gauge was only 14 feet above ground.

In consequence, for the Buster trials it seemed advisable to devise an experiment permitting more extensive exploitation of the suspected phenomena. Accordingly two 50-ft towers (Fig. 1) were erected for Shot Easy, and Wiancko type pressure gauges were mounted in the sides of the cross pipes (Fig. 2) at levels of 0, 5, 10, 25, and 50 feet. Locations of the two

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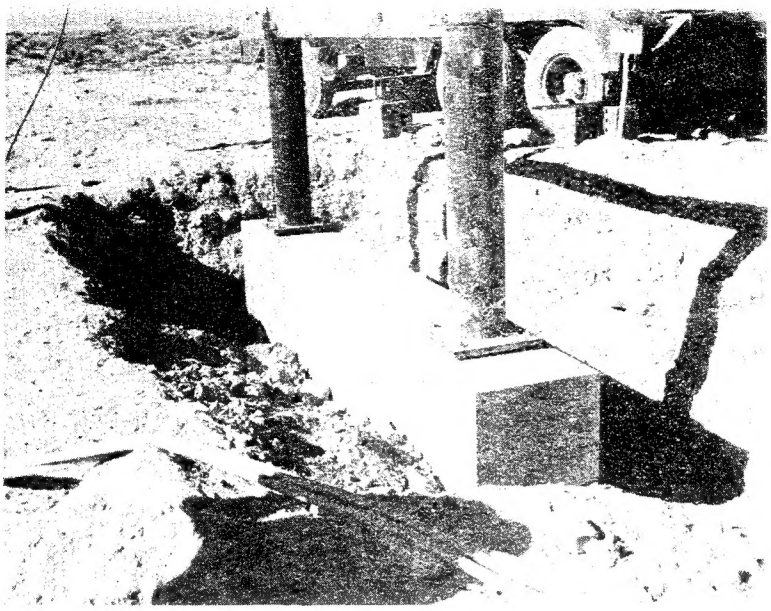

Fig. 1. -- Base of a 50-ft tower

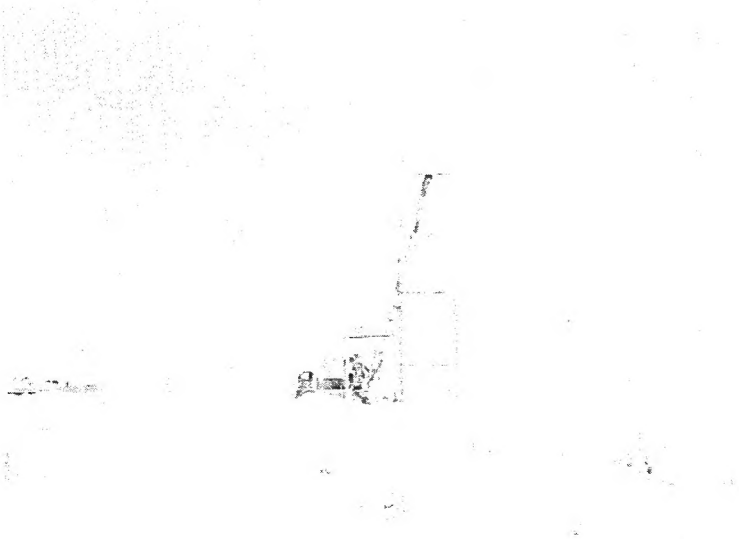

Fig. 2. -- View of 50-ft tower

towers were designated as stations 601b and 604b. (Figure 3 illustrates details of the blast line layout.) The distance parameters are given in Table I, as are the code designations of the various pressure gauges and their records. The adjacent horizontal-pad ground level stations, 601a and 604a, are included in this discussion because of their proximity.

With airflow considerations in mind, flush mounting of the gauges at about the mid-point in the sides of the horizontal pipes of the towers is probably about as good a choice as could be made for these particular towers, oriented as shown in Fig. 3. Furthermore, aerodynamic design of the towers may be criticized on the ground that the vertical leading leg no doubt perturbs the flow and the trailing leg is not far enough removed from the gauge to prevent some further perturbation. However, it is not felt that these difficulties interfere with readings of either arrival time or peak pressure. Another report[3] of the Buster series, a critique of the overall accuracy of the gauge system, indicates that pressure readings may not be considered more accurate than 5 per cent, but that errors of 10 to 20 per cent are possible. Relative times may be expected to err within about 1 millisecond.

The most obvious feature of the records (Figs. 4-15) is the rapid rate of pressure rise of all the instruments at station 604 in contrast with the much slower and broadened responses at station 601. All the records from station 601 show a considerable number of rapid fluctuations while those from station 604 are in general fairly clean.

Table II presents critical values from the plotted records: arrival times, rise times, and peak pressures. Within the previously stated limits of pressure error, for each station the peak pressure values at all gauges agree although the horizontal-pad readings appear to be slightly lower.

In Fig. 16 the arrival times and peak values of the pressure disturbances have been plotted as a function of the distance of the several gauges above ground for station 601; in Fig. 17 corresponding data have been plotted for station 604.

The record 5B2P50 is so poor that no estimate of times can be made from it.

For the other gauges peak pressures and times of peak pressures are estimated from the records; fluctuations made useless the direct reading of the highest recorded values.

At none of the gauge levels does there appear to be much if any correlation between any of the quantities, such as pressure arrival time or time of peak pressure, with measured height above the ground.

Conclusions

Records from the experiment to determine variations of blast quantities as a function of height do not provide any apparent correlation. Peak pressures, initial arrival times, and times of peak pressures are independent of height above the ground except that the peak pressures obtained from the ground pad records appear to be slightly lower than the others, and the shock appears to arrive sooner at the ground gauges. These findings appear to be consistent with those of the Greenhouse report[2] mentioned earlier.

[redacted]

TABLE I

Buster Shot Easy: 31.4 kt Burst height: 1,314 ft $\frac{Ht}{W^{1/3}} = 422$

Station	Ground zero distance (Fig. 3) (ft)	Measured ground distance zero (ft)	Measured slant range (ft)
601	2,070.79	2,031	2,420
604	2,940.31	2,910	3,195

Station	Height above ground (ft)	Gauge No.	Gauge record No.	Fig. No.
601a	0	B2S	5B2S	4
601b	0	B2P0	5B2P0	5
601b	5	B2P5	5B2P5	6
601b	10	B2P10	5B2P10	7
601b	25	B2P25	5B2P25	8
601b	50	B2P50	5B2P50	9
604a	0	DS	5DS	10
604b	0	DP0	5DP0	11
604b	5	DP5	5DP5	12
604b	10	DP10	5DP10	13
604b	25	DP25	5DP25	14
604b	50	DP50	5DP50	15

TABLE II

Gauge record No.	Height above ground (ft)	Peak pressure (psi)	Arrival time (msec)	Time of peak pressure (msec)
Station 601				
5B25	0	8	868	1,170
5B2P0	0	11	870	1,170
5B2P5	5	9.5	870	1,180
5B2P10	10	11	870	1,165
5B2P25	25	10	878.5	1,190
5B2P50	50	9	-	-
Station 604				
5DS	0	7.8	1,489	1,530
5DP0	0	8.5	1,493	1,540
5DP5	5	8.6	1,484.4	1,530
5DP10	10	8.8	1,493	1,540
5DP25	25	8.8	1,500	1,530
5DP50	50	8.8	1,499.2	1,530

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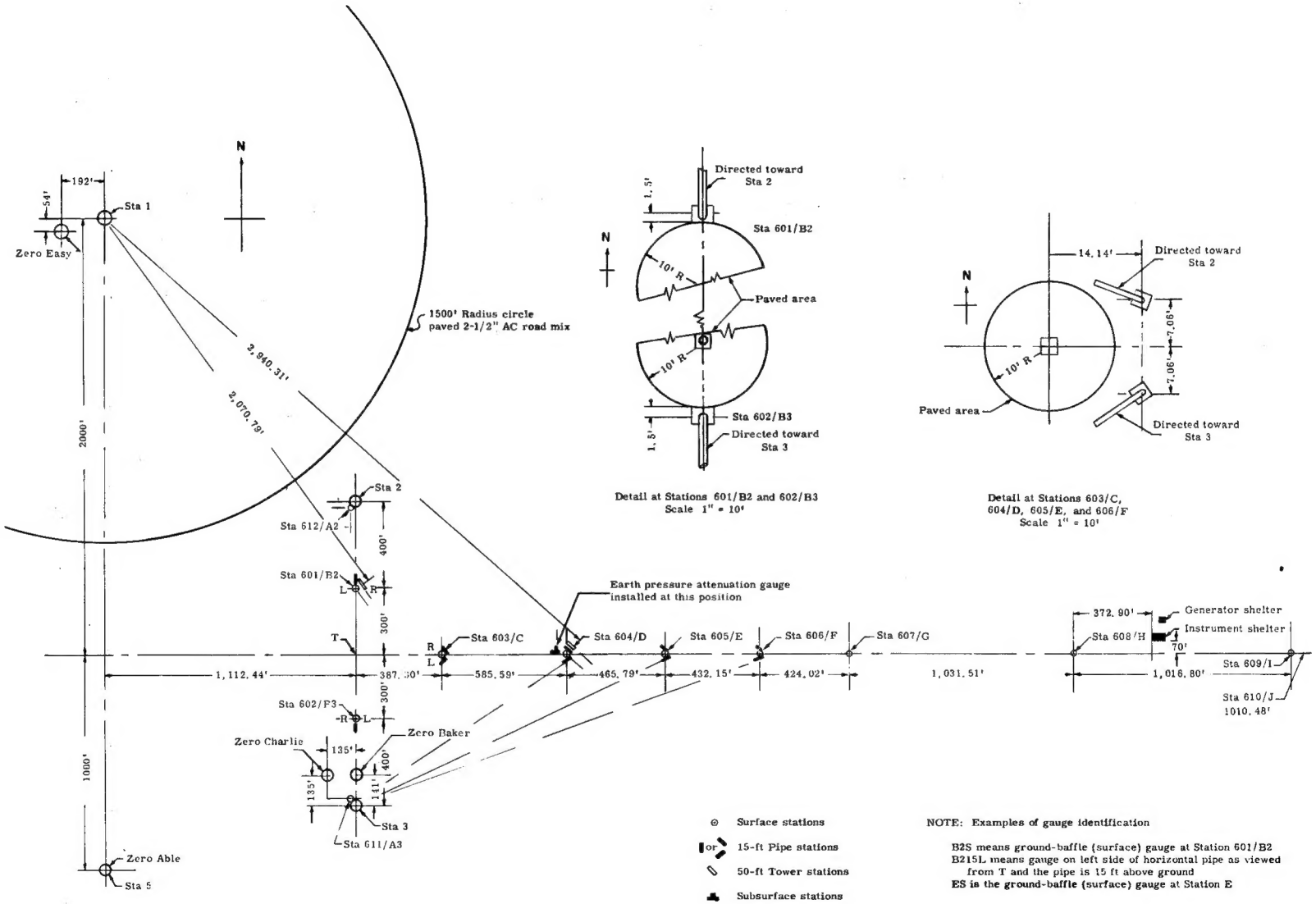

Fig. 1. -- Site plan

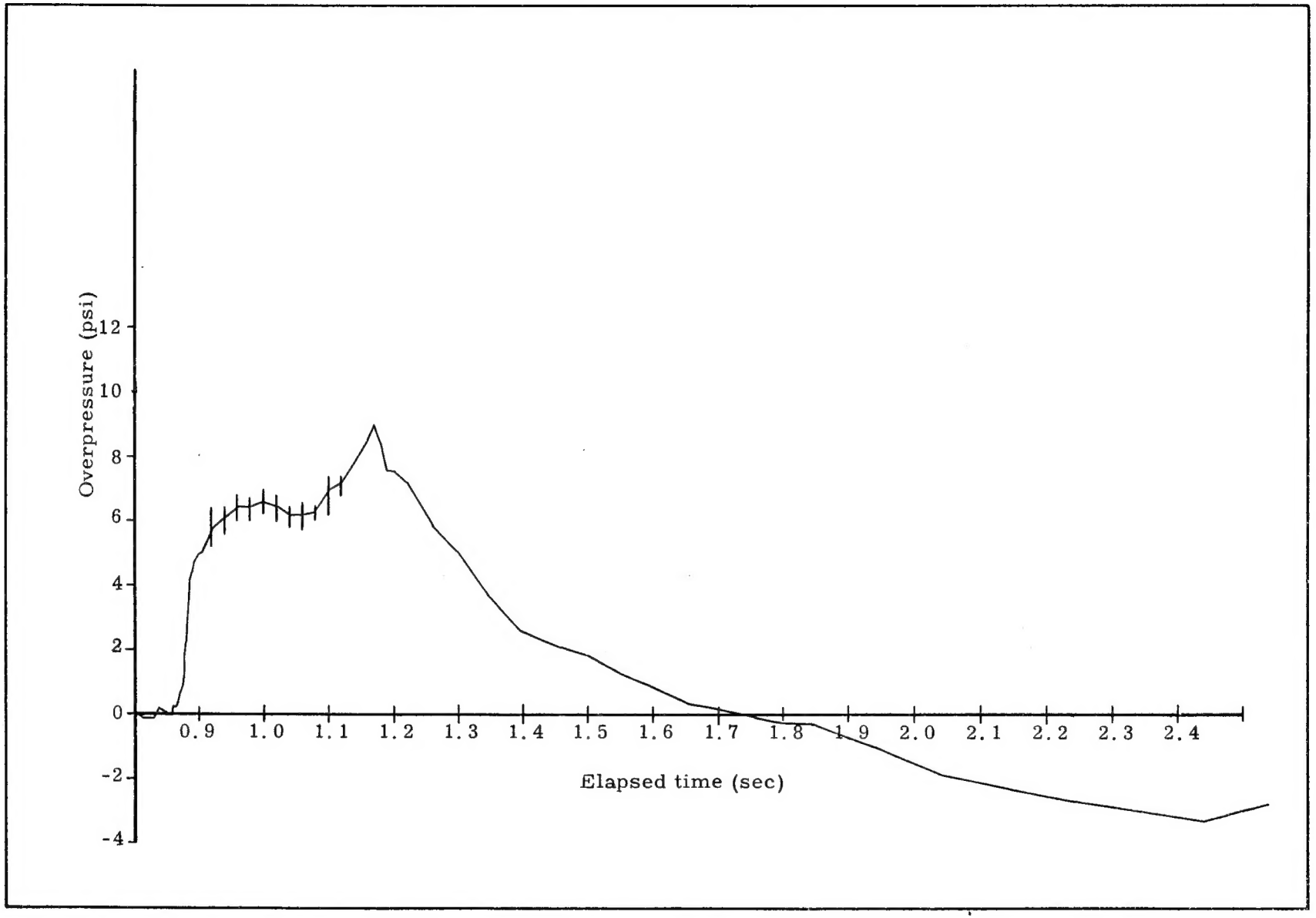

Fig. 4. -- Shot Easy (B2S) (ground baffle) (distance from ground zero: 2,031 ft)

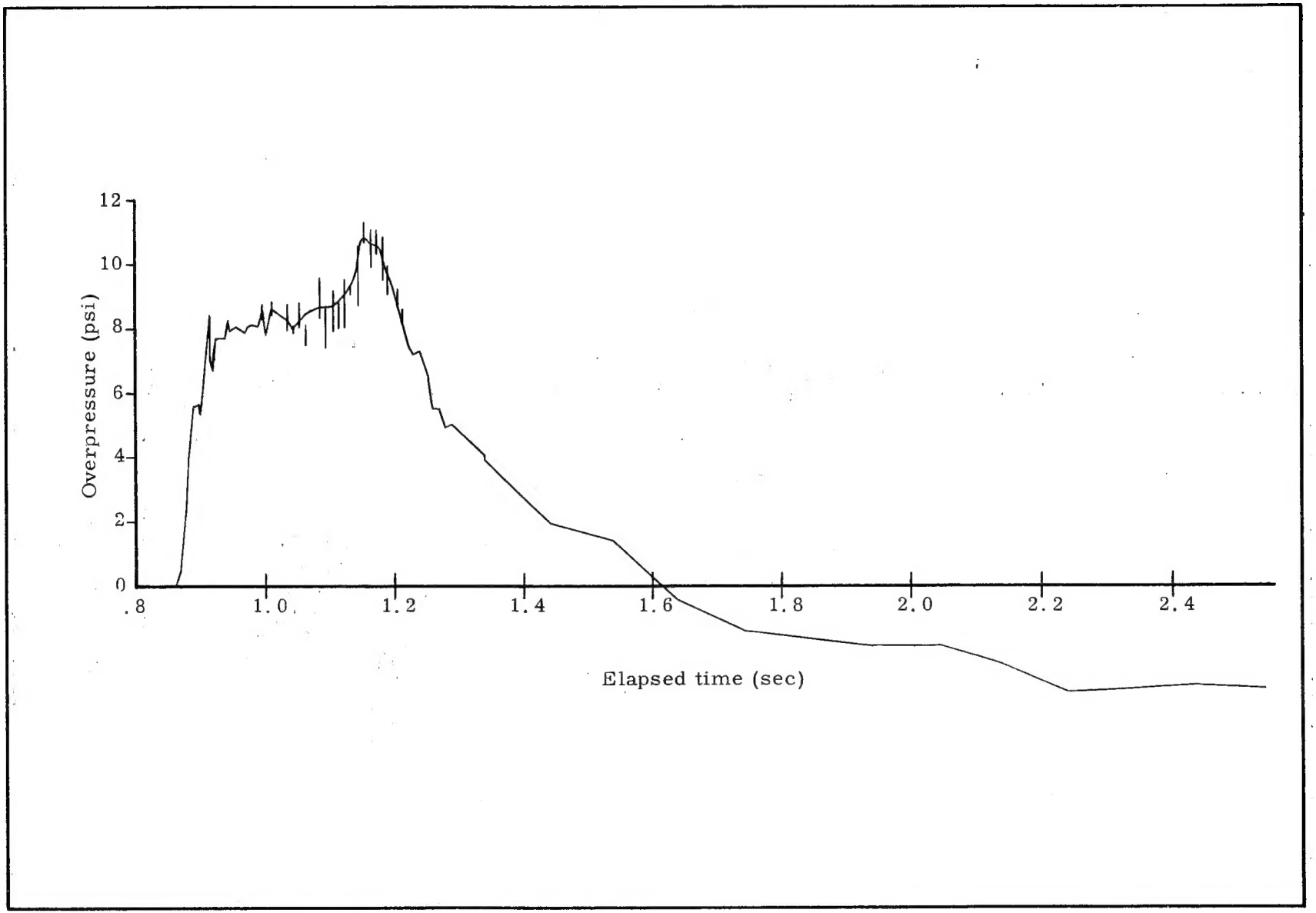

Fig. 5. -- Shot Easy (E2PO) (ground baffle) (distance from ground zero: 2,031 ft)

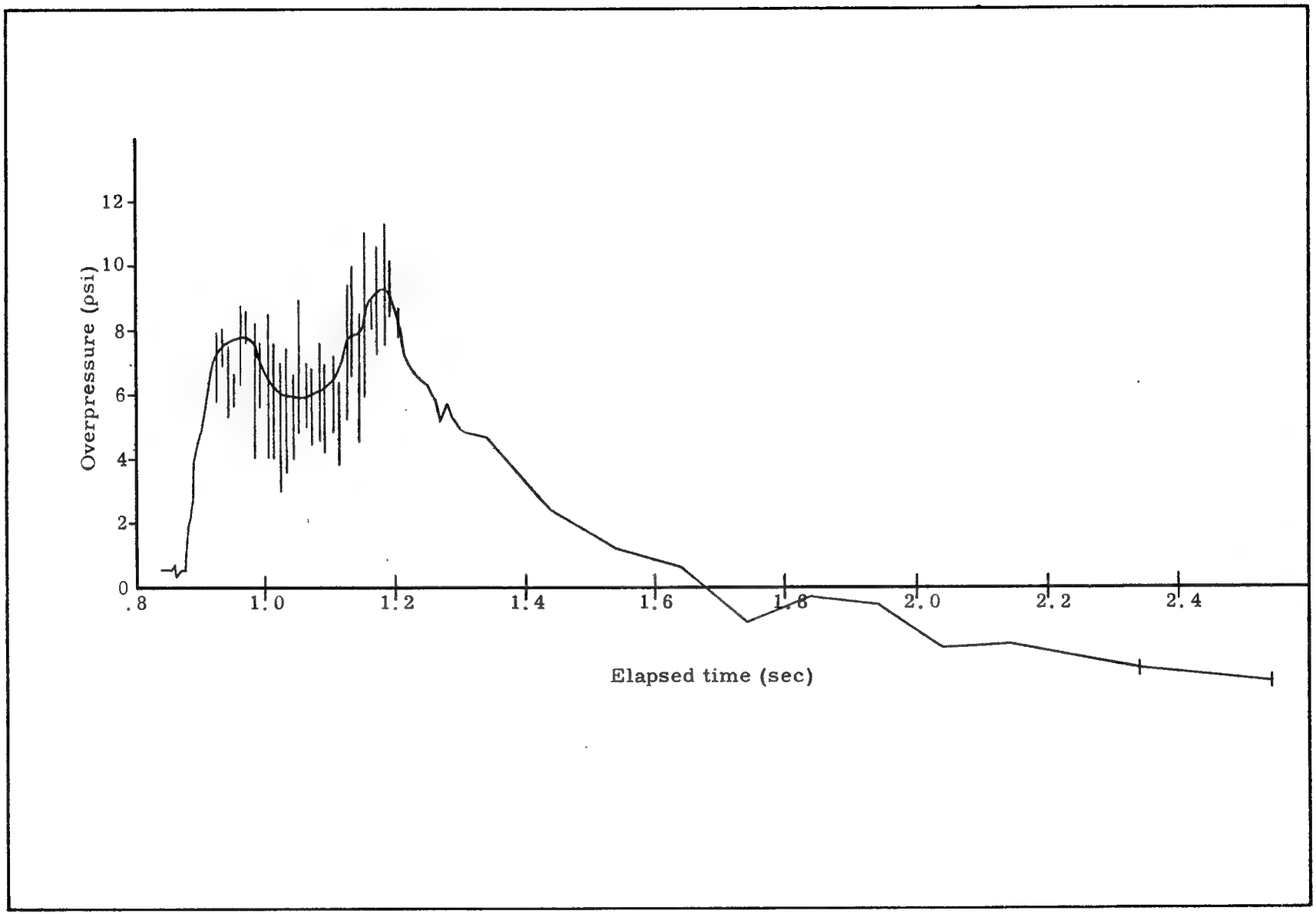

Fig. 6. -- Shot Easy (E2P5) (gauge 5 ft above ground) (distance from ground zero: 2,031 ft)

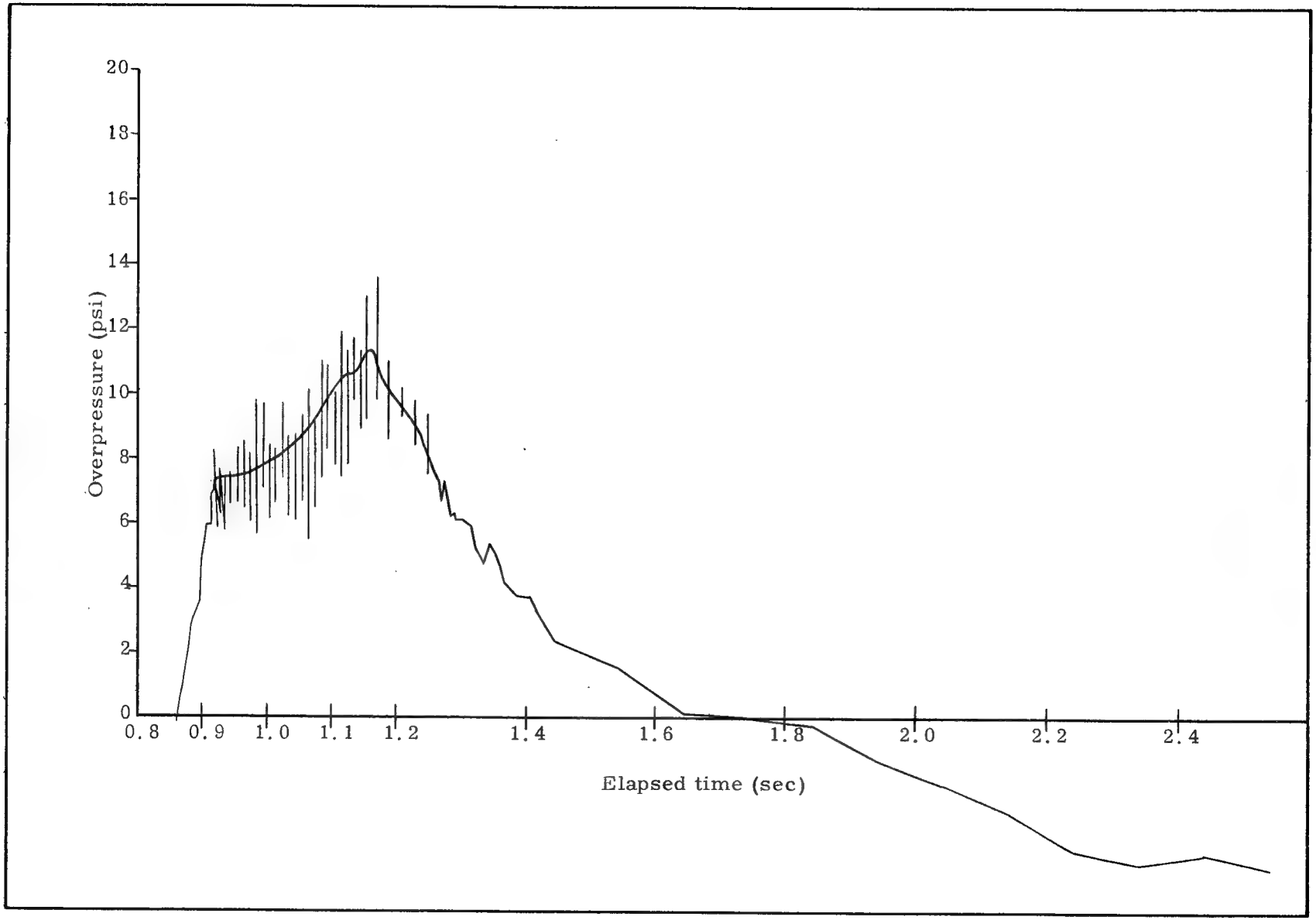

Fig. 7. -- Shot Easy (B2P10) (gauge 10 ft above ground) (distance from ground zero: 2,031 ft)

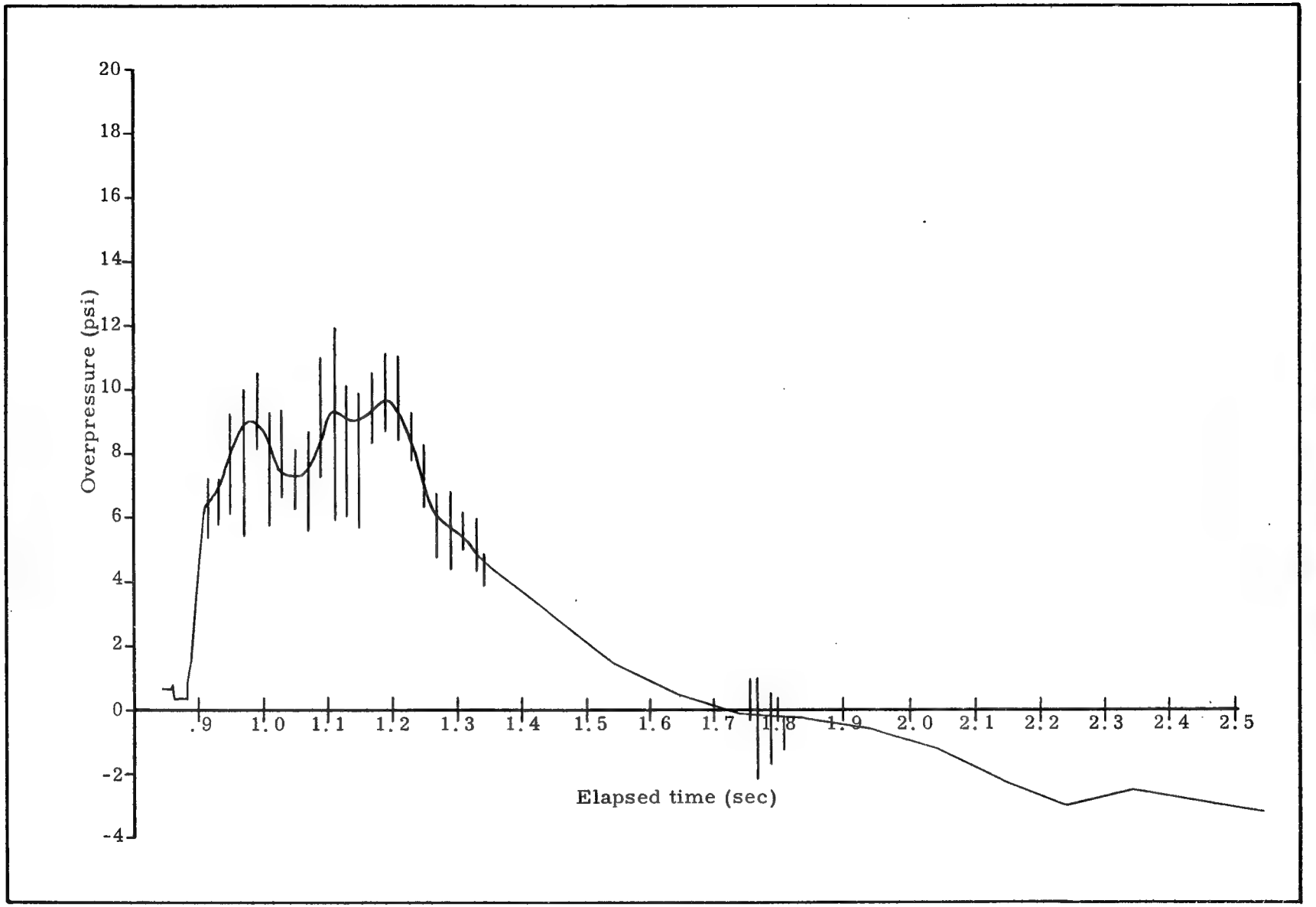

Fig. 8. -- Shot Easy (B2P25) (gauge 25 ft above ground) (distance from ground zero: 2,031 ft)

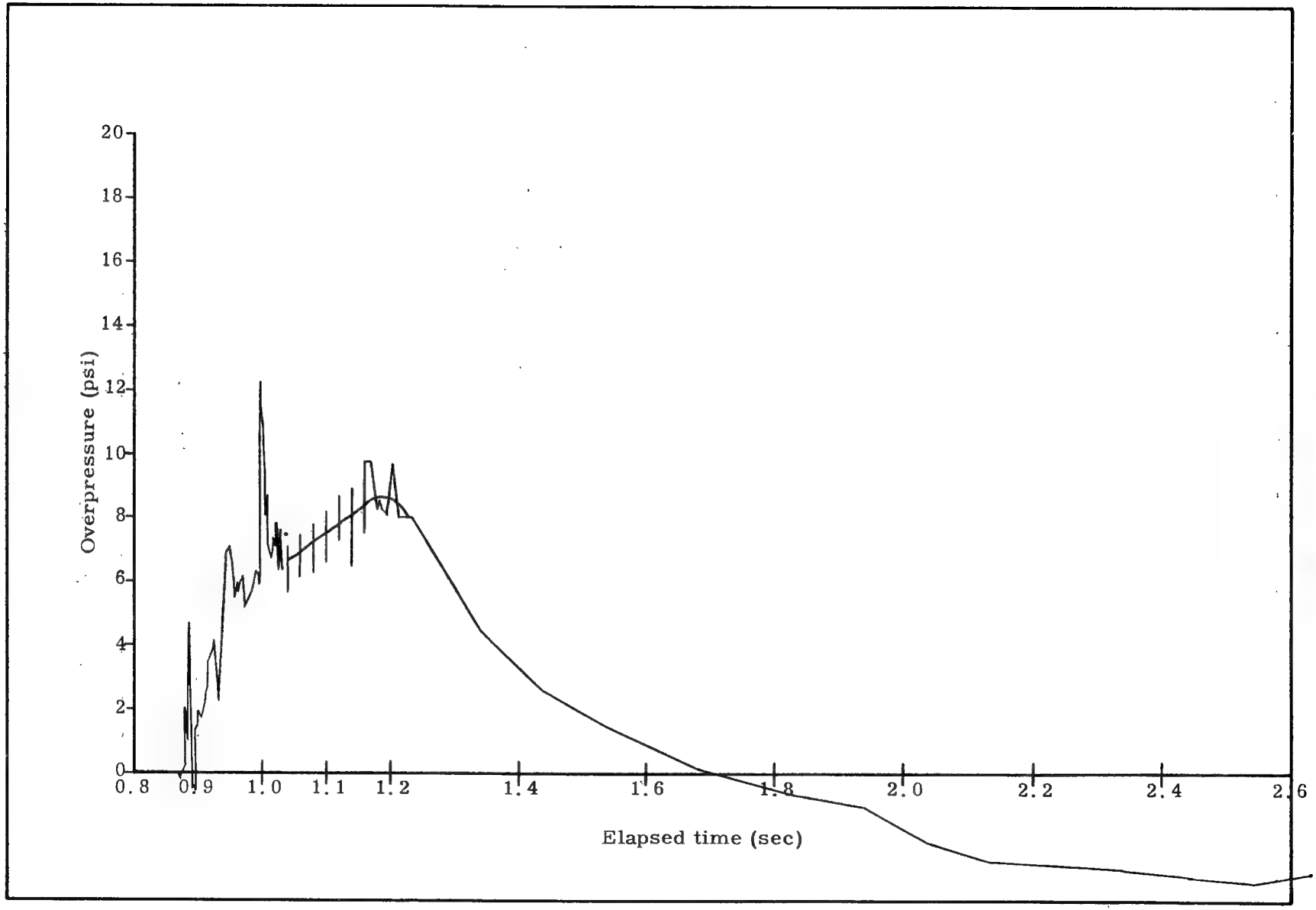

Fig. 9. -- Shot Easy (E2P50) (gauge 50 ft above ground) (distance from ground zero: 2,031 ft)

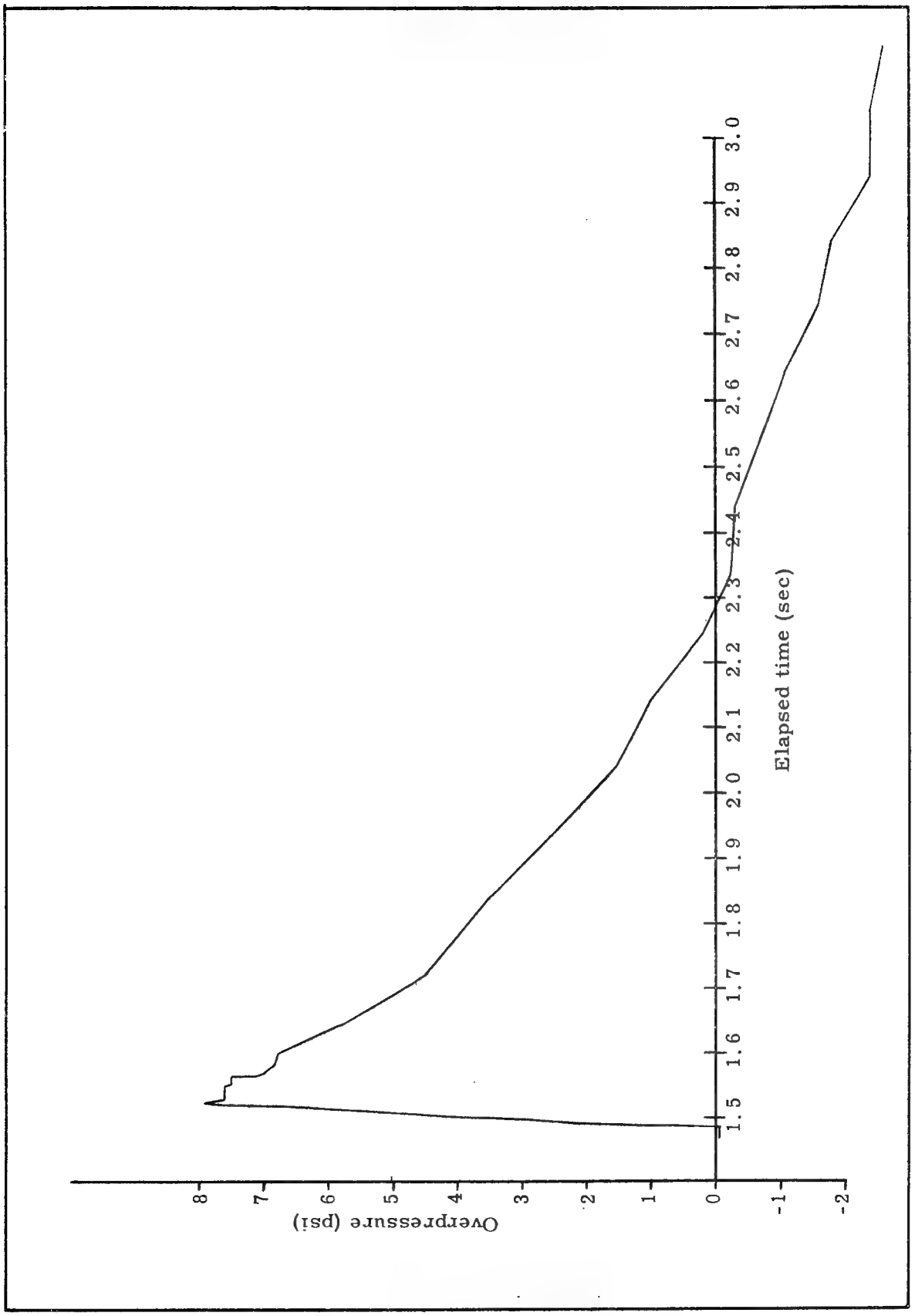

Fig. 10. -- Shot Easy (DS) (ground baffle) (distance from ground zero: 2,910 ft)

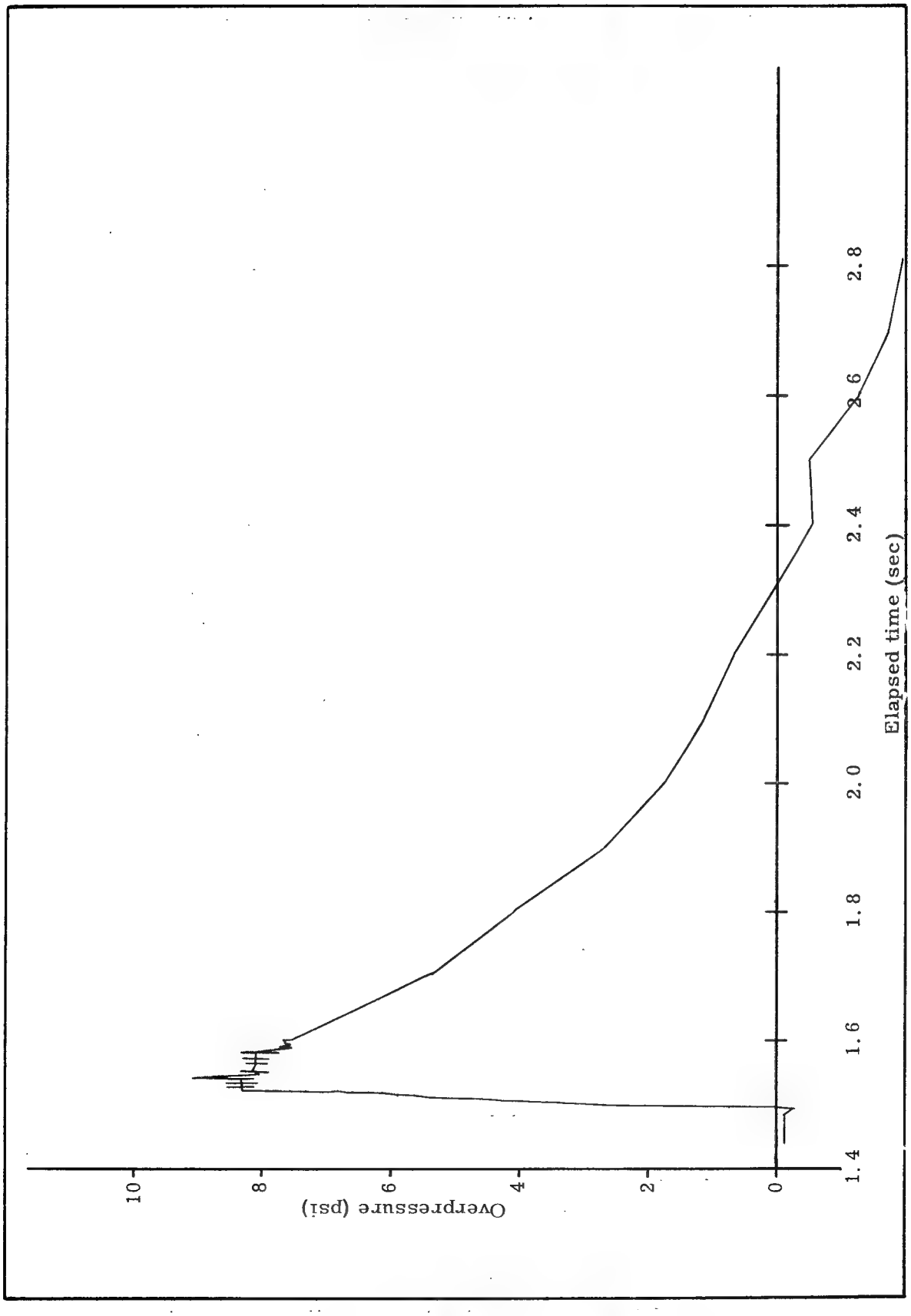

Fig. 11. -- Shot Easy (DPO) (ground baffle) (distance from ground zero: 2,910 ft)

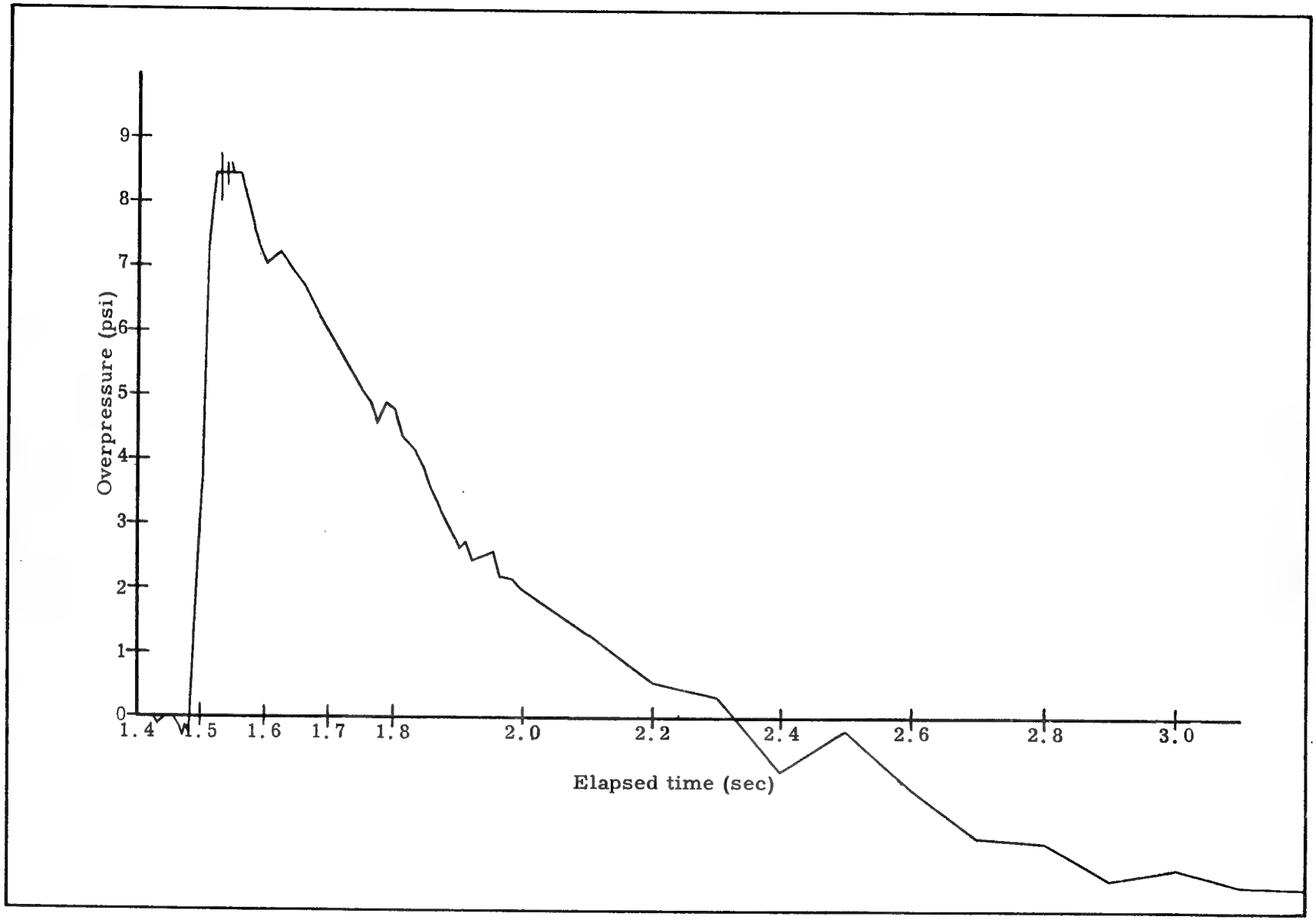

Fig. 12. -- Shot Easy (DP5) (gauge 5 ft above ground) (distance from ground zero: 2,910 ft)

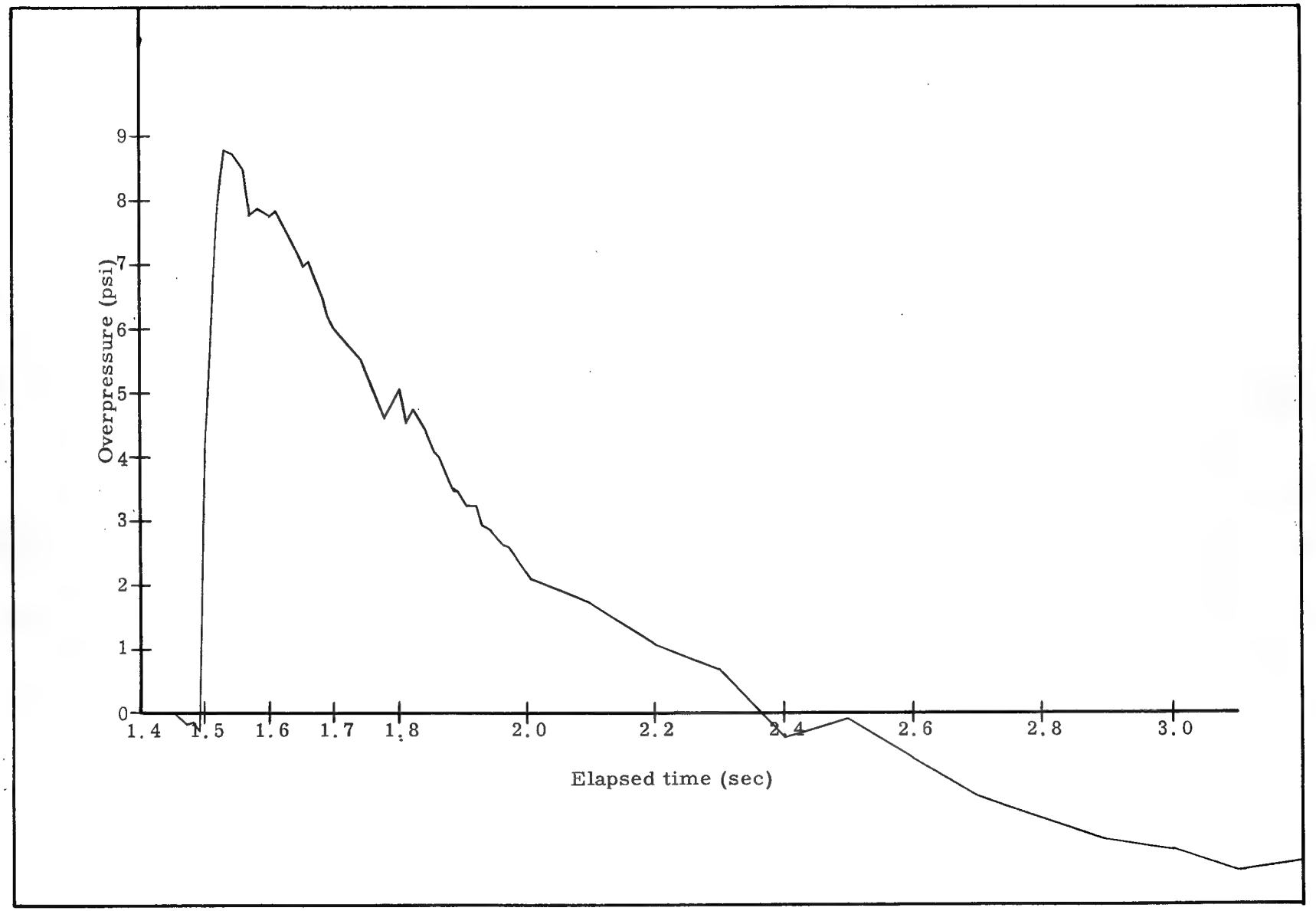

Fig. 13. -- Shot Easy (DP10) (gauge 10 ft above ground) (distance from ground zero: 2,910 ft)

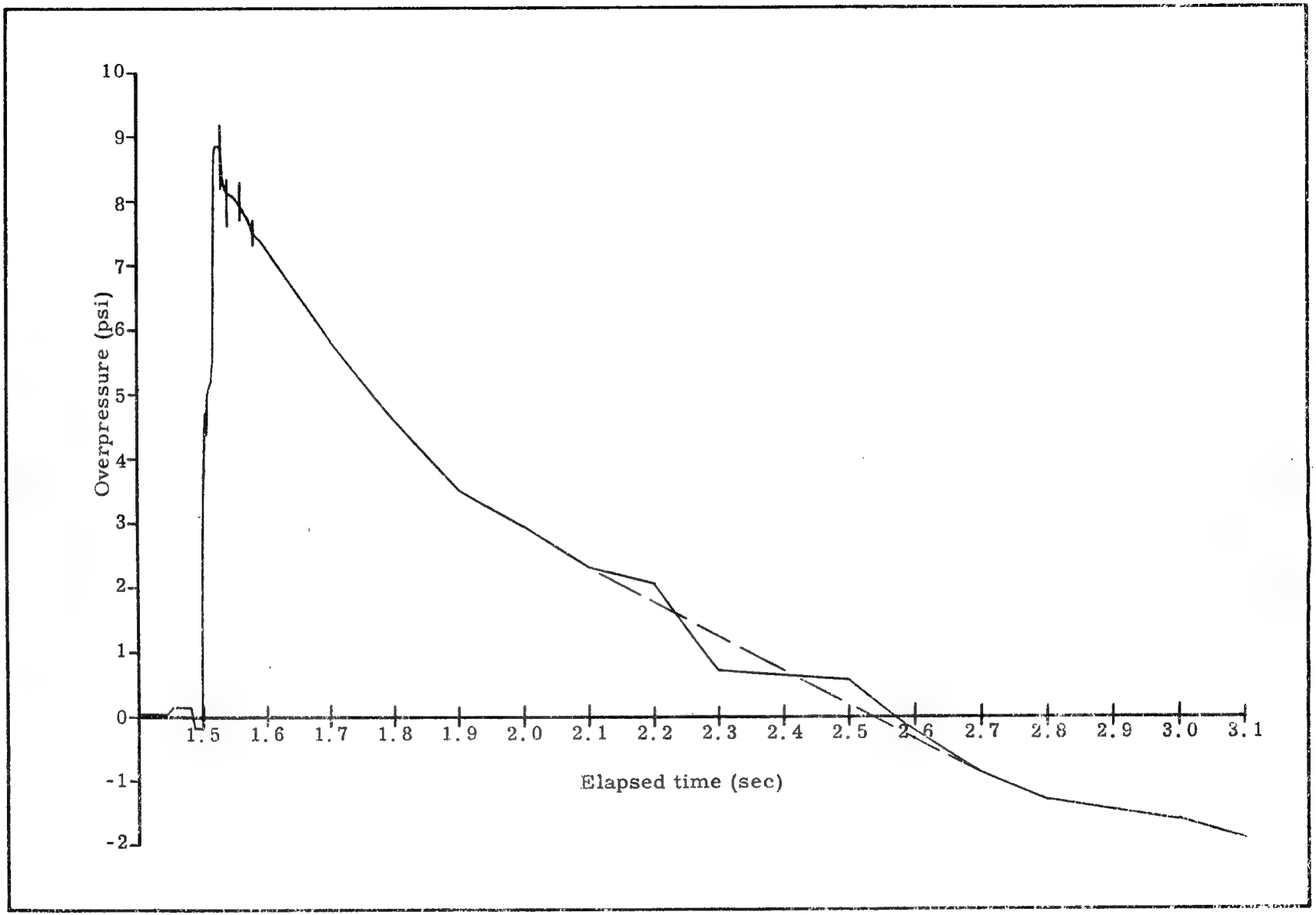

Fig. 14. -- Shot Easy (DP25) (gauge 25 ft above ground) (distance from ground zero: 2,910 ft)

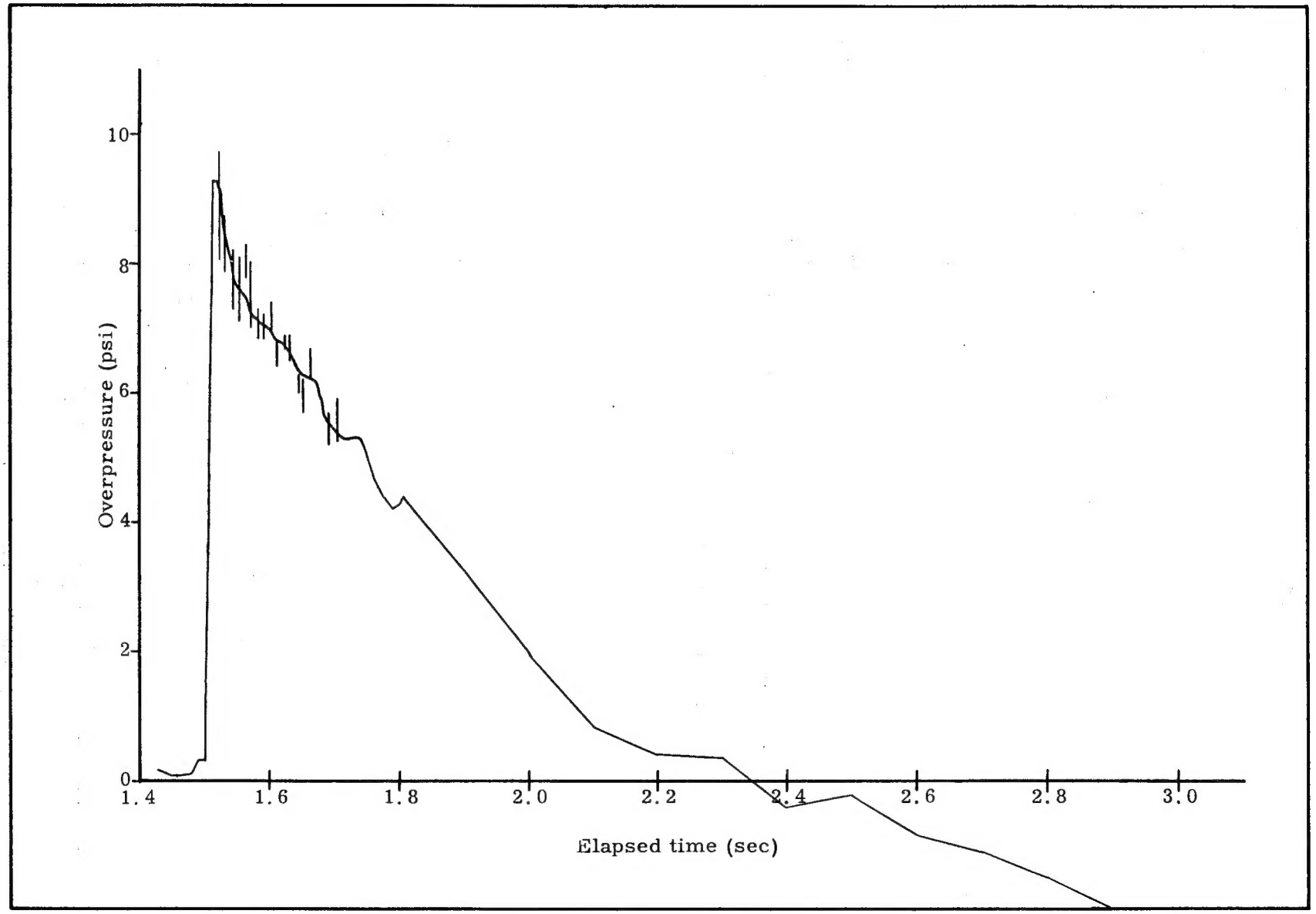

Fig. 15. -- Shot Easy (DP50) (gauge 50 ft above ground) (distance from ground zero: 2,910 ft)

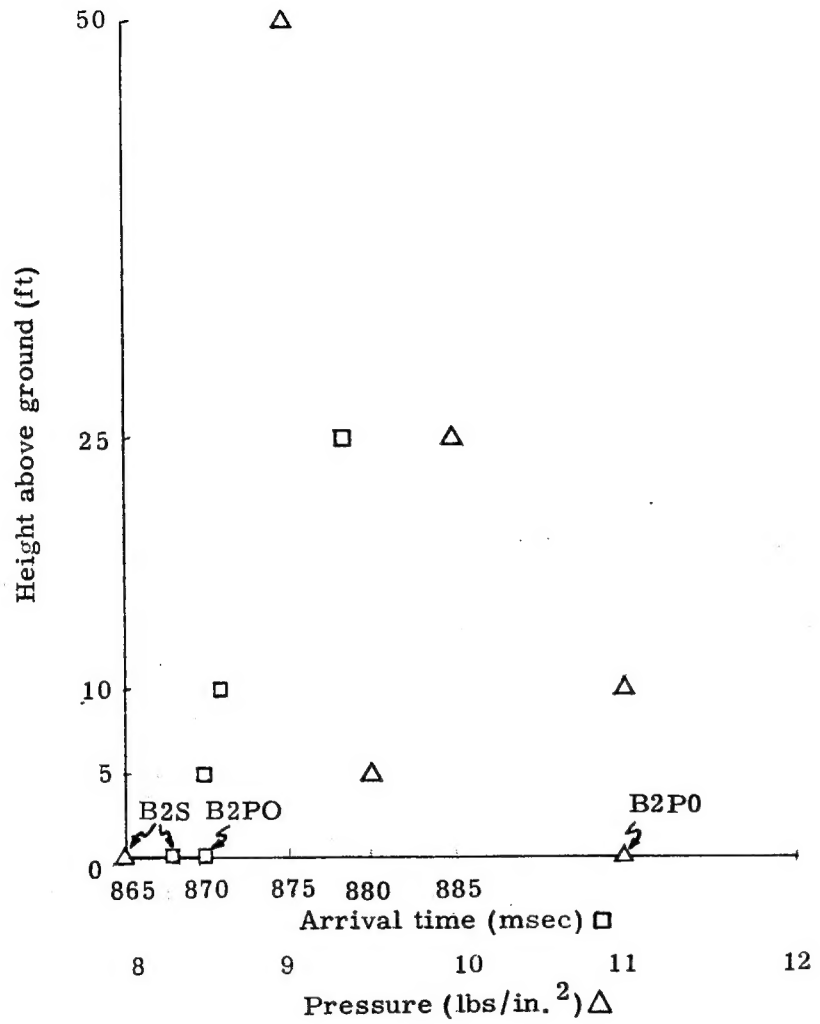

Fig. 16. -- Arrival times and peak pressures vs distance of the gauges above ground (station 601)

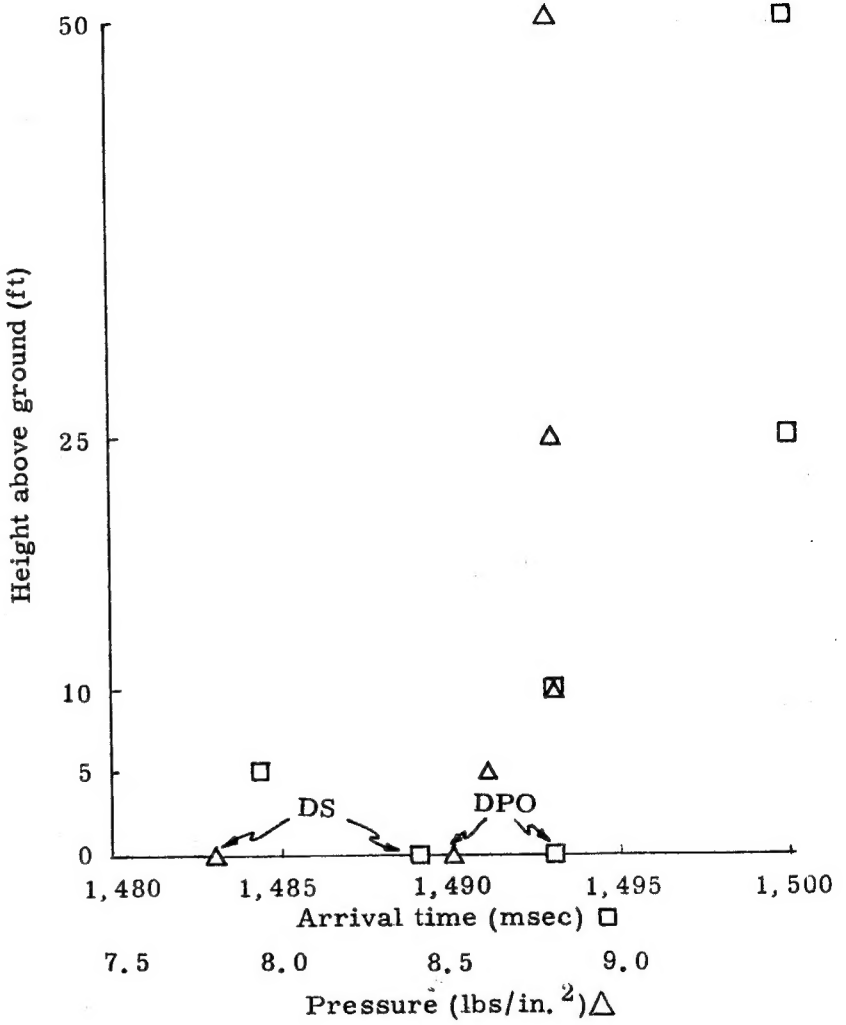

Fig. 17. -- Arrival times and peak pressures vs distance of the gauges above ground (station 604)

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1. Northrup, P. A., Instruments for the Structures Program, Annex 3.4, Part II (Greenhouse report WT-10, to be published)

2. Price, J. F., et al, Pressure-Time Measurements in the Mach Region with Variable Inductance Diaphragm Gages, Annex 1.6, Part IV, Section I (Greenhouse report, to be published)

3. Murphey, B. F., Operation Buster - Some Measurements of Overpressure-Time vs Distance for Airburst Bombs, Buster-Jangle Report WT-304, March 4, 1952 (to be published)

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